DEPARTMENT OF ENVIRONMENTAL QUALITY
PERMITTING and COMPLIANCE DIVISION
MONTANA POLLUTANT DISCHARGE ELIMINATION SYSTEM (MPDES)

Statement of Basis

Permittee:	Vaughn-Cascade County Sewer District
Permit No.:	MT0021440
Receiving Water:	Sun River
Facility Information:	
Name	Vaughn Domestic Wastewater Treatment Facility
Location	1110 6th Ave
Facility Contact:	George Duffy, operator P.O. Box 429 Vaughn, MT 59487 (406) 590-6987
Fee Information:	
Number of Outfalls	1 (for fee purposes)
Outfall – Type	002- domestic wastewater

I. Permit Status

This is a renewal of existing Montana Pollutant Discharge Elimination System (MPDES) permit MT0020249 for the Vaughn Cascade County Sewer District. This facility serves the unincorporated community of Vaughn.

The previous permit was effective October 1, 1999 and expired December 31, 2003. The permittee submitted fees and a renewal application on September 10, 2003. A final review of the application was completed by the Department of Environmental Quality (Department) on August 24, 2004. As directed by the Administrative Rules of Montana (ARM) 17.30.1322(4)(a), because the permittee has submitted a complete renewal application, the present permit is administratively extended until a new permit is issued.

II. Facility Information

A. Facility Description

The permittee operates a three-cell aerated lagoon system that continuously discharges to the Sun River. Treated effluent is not disinfected prior to discharge. A V-notch weir is present in the effluent control structure for flow measurement (Figure 1) and the facility has an ultra-sonic flow totalizer. The facility is equipped for multilevel draw-off from the third cell.

The existing facility was constructed in 1997 and replaced the former two-cell aerated lagoon. The former lagoon facility discharged to the Vaughn Slough, a sluggish backwater channel that ultimately drains to the Sun River. The previous permit was written to include both the former and the updated system and, as such, identified two outfalls, Outfall 001 to the Vaughn Slough and Outfall 002 to the Sun River. The previous permit contains limits and monitoring requirements for both outfalls. During the 1997 upgrades, Outfall 001 was eliminated and no longer functioned as an outfall (Neil Consultants, 1999). The 1997 as-built drawings depict Outfall 001 as an emergency overflow only. The renewal application identifies only Outfall 002 (Sun River) as the discharge location. Observations made during a June 2004 compliance inspection verified that the only viable outfall is Outfall 002 to the Sun River.

The existing facility does not have disinfection capabilities. For Outfall 002, the previous permit did not contain a limit or require effluent monitoring for fecal coliform bacteria. The Statement of Basis (SOB) for the previous permit had a limit calculation for fecal coliform bacteria that used mixing dilution available from the Sun River. The SOB states that the monthly mean fecal coliform limit is 461,000 organisms/100 mL and the weekly mean limit is 922,000 organisms. The design engineers deemed the facility capable of meeting effluent pathogen limits without additional treatment. The Operation and Maintenance (O&M) manual states that the chlorination system from the former facility would remain in place until such time that the Department determines disinfection is required (Neil, 1997).

Table 1: Current Design Criteria Summary (Neil Consultants, 1999)	
Facility Description: **Three-cell aerated lagoon system**	
Construction Date: 1997	Modification Date: none
Design Population: 542	Current Population: 542
Design Flow, Average (mgd): 0.0894	Design Flow, Maximum Day (mgd): 0.3576
Primary Cells: 2	Secondary Cells: 1
Number Aerated Cells: 3	Minimum Detention Time-System (days): 26
Design BOD Removal (%): unknown	Design BOD Load (lb/day): 108
Design SS Removal (%): unknown	Design SS Load (lb/day): 119
Influent Flow (mgd): unknown	Source: unknown
Collection System Combined [ ] Separate [X]	Estimated I/I: unknown
Disinfection (Y/N): none	Type: none
Discharge Method: Continuous	

B. Effluent Characteristics

Effluent data from the facility Discharge Monitoring Reports (DMR) for the Period of Record (POR) January 2002 through February 2007 are summarized in Table 2.

The permittee sampled carbonaceous biochemical oxygen demand (CBOD) from January 2003 through November 2004. These data are summarized in Table 2. The permit did not have a limit or require monitoring for CBOD.

Table 2: DMR Effluent Characteristics [1] for POR January 2002 through November 2006

Parameter	Location	Units	Previous Permit Limit (7-d/30-d)	Minimum Value	Maximum Value	Average Value	Number of Samples
Flow, Daily Average	Effluent	mgd	NA [2]	0.025	0.073	0.044	61
Biochemical Oxygen Demand (BOD_5)	Influent	mg/L	NA [3]	---	---	---	---
	Effluent	mg/L	45/30	6	117	27	61
	Effluent	% removal	85 [4]	---	---	---	---
	Effluent	lb/day	7.5 [5]	1.8	32.3	9.7	61
Carbonaceous Oxygen Demand (CBOD)	Effluent	mg/L	NA [6]	5	29	12.4	22
Total Suspended Solids (TSS)	Influent	mg/L	NA [3]	---	---	---	---
	Effluent	mg/L	135/100	10	135	52	61
	Effluent	% removal	NA [3]	---	---	---	---
	Effluent	lb/day	25 [5]	2.1	64.1	19.7	61
Fecal Coliform Bacteria [7]	Effluent	Number per 100 mL	[3]	---	---	---	---
pH	Effluent	s.u.	6.0 to 9.0 [4]	---	---	---	---
Temperature	Effluent	ºC	NA [3]	---	---	---	---
Total Residual Chlorine	Effluent	mg/L	NA [3]	---	---	---	---
Total Ammonia as N, annual	Effluent	mg/L	NA [2]	0.09	35.1	10.6	58
Total Kjeldahl Nitrogen	Effluent	mg/L	NA [2]	1.6	34.7	15.3	58
Nitrate + Nitrite as N	Effluent	mg/L	NA [2]	0.12	14.9	3.5	58
Total Nitrogen [8]	Effluent	mg/L	NA [2]	3.5	35.4	18.8	58
		lb/day	8.4 [5]	0.7	13.0	6.7	58
Total Phosphorus	Effluent	mg/L	NA [2]	2.4	6.0	3.9	56
		lb/day	2.1 [5]	0.5	1.9	1.3	56
Dissolved Oxygen	Effluent	mg/L	NA [3]	---	---	---	---
Oil and Grease	Effluent	mg/L	NA [3]	---	---	---	---
		lb/day	NA [3]	---	---	---	---
Total Dissolved Solids	Effluent	mg/L	NA [3]	---	---	---	---

Footnotes: NA - Not applicable

(1) Conventional and Non-conventional Pollutants only, table does not include information on toxic pollutants.
(2) No effluent limit in previous permit, monitoring requirement only.
(3) No limit or monitoring requirement in previous permit.
(4) Effluent limit in previous permit, no monitoring required.
(5) Nondegradation Annual Average Load Value, not permit limitation.
(6) No limit or monitoring requirement in previous permit. Monitoring completed by permittee and submitted separate of monthly DMRs.
(7) Sample period is April 1 through October 31.
(8) Calculated as the sum of TKN and Nitrite + Nitrate-N concentrations.

C. Compliance History

The permittee reported 18 BOD_5 and five TSS violations during the POR. These data are summarized in Table 3. The permittee submitted written explanations documenting most of the effluent violations. Seven were described as O&M related (out-of-service, frozen, or repositioned aerators, or off-line lagoon) with explanations of O&M changes to counter exceedances. Eight exceedances were attributed to natural (turn-over or algae bloom) or unknown causes.

Table 3. Outfall 002 Limit Exceedances during POR

Month	2002	2003	2004	2005	2006
	mg/L BOD_5				
January	32	---	---	34	---
March	---	---	34	35	---
April	84	42	84	32	---
May	39	---	69	49	117
June	48	---	50	38.5	39.9
July	---	---	53	---	---
December	---	---	---	---	35
	mg/L TSS				
May	---	135	125	---	130
June	---	---	108	---	---
September	---	---	---	109	---

An MPDES compliance inspection was completed on June 11, 2004. The inspector observed signs of lacking O&M and poor record keeping and data management. A Department issued violation letter dated September 9, 2004, was sent to the permittee requiring that all cited violations be corrected within 60 days after receipt of the letter. On November 14, 2004, the Department received a written plan, prepared by Neil Consultants for the permittee, that addressed the violations. The engineering plan outlined activities and maintenance schedules. A November 16, 2004 dated letter was submitted by the permittee that outlined the steps that had been made to correct the deficiencies noted in the inspection.

III. Technology-Based Effluent Limits

The Montana Board of Environmental Review has adopted by reference 40 CFR 133 which defines minimum treatment requirements for secondary treatment, or the equivalent, for publicly owned treatment works (POTW) (ARM 17.30.1209). Secondary treatment is defined in terms of effluent quality as measured by Biochemical Oxygen Demand (BOD_5), Total Suspended Solids (TSS), percent removal of BOD_5 and TSS, and pH.

National secondary treatment standard requirements may be modified on a case-by-case basis for facilities that are eligible for treatment equivalent to secondary (TES) treatment (40 CFR 133.101(g)) or alternative state requirements (ASR) for TSS. To determine if a facility is

eligible for TES the facility must meet the requirements of 40 CFR 133.101(g), summarized as follows:

1. The BOD_5 and TSS consistently achievable through proper operation and maintenance of the treatment works exceed the minimum effluent quality described for secondary treatment (40 CFR 122.102).
2. The treatment works utilize a trickling filter or waste stabilization pond, and
3. The treatment works utilize biological treatment that consistently achieves a 30-day average of at least 65 percent removal (40 CFR 133.101(k)).

Water quality must not be adversely affected by the application of TES. Effluent limits for BOD_5 cannot be relaxed unless the permittee has demonstrated that the relaxed from nation secondary treatment standard requirements will not result in a violation of water quality standards in the receiving water.

In addition to TES, permitting agencies may give special consideration to treatment works that employ waste stabilization ponds as the primary method for treating wastes. Alternative state requirements (ASR) may be incorporated into permits for lagoons if historic data for the system indicates that effluent limits based on TES cannot be consistently achieved through proper O&M. The 30-day ASR for TSS in Montana is 100 mg/L [49 FR 37005; September 20, 1984]; the Department employed a 135mg/L TSS for a 7-day limit based on best profession al judgment. New facilities are not eligible for ASR.

CBOD may be substituted for BOD_5, when nitrification is occurring and influencing BOD_5 values. The use of CBOD as an effluent limit minimizes false indications of poor facility performance as a result of nitrogenous pollutants. The Department has the discretion to set CBOD effluent limits under 40 CFR 133.102(a)(4), in lieu of BOD_5 limits. The 30-day average CBOD national secondary treatment standard is 25 mg/L.

The permittee sampled monthly effluent CBOD in 2003 and 2004. Of the 22 reported CBOD data points, three exceeded the 30-day standard of 25 mg/L. For the same monitoring period, the permittee reported effluent BOD_5 exceedances for the same months as the high CBOD values. The CBOD results do not indicate that historical BOD_5 exceedances are influenced strictly by nitrification. Rather, the CBOD results indicated that operation and maintenance (O&M) has more influence on the quality of the permittee's effluent. BOD_5 effluent limits will be used in this permit.

Nondegradation Load Allocations

The provisions of ARM 17.30.701 - 718 (Nondegradation of Water Quality) apply to new or increased sources of pollution [ARM 17.30.702(18)]. Because of the 1997 upgrades and increased design flow, Outfall 002 is an increased source for the purposes of nondegradation. ARM 17.30.702 defines "new or increased source" as an activity resulting in a change of existing water quality occurring on or after April 29, 1993. Sources that are in compliance with the conditions of their permit and do not exceed the limits established in the permit or determined from a permit previously issued by the Department are not considered new or increased sources.

In the 1998 permit renewal, the Department calculated BOD_5, TSS, total nitrogen (TN) and total phosphorus as P (TP) nondegradation loads for Outfall 002 based on the design flow of the former facility, 0.030 mgd. The calculated nondegradation loads are presented in Table 4.

The 1997 upgrade was an increase in discharge flow from 0.030 mgd to 0.0894 mgd. The Department did not apply the nondegradation loads to the upgraded facility BOD_5 and TSS effluent limits. The actual average loads discharged from the facility are presented in Table 4 and were obtained from self-monitoring data submitted by the permittee for the POR. The actual BOD_5 annual average loads constantly exceed the nondegradation load.

Effluent BOD_5 and TSS limits based on the nondegradation loads and the increased design discharge of 0.0894 mgd are back-calculated as follows:

$$BOD_5: \quad \frac{7.5 \text{ lbs/day}}{0.0894 \text{ mgd} * 8.34} = 10 \text{ mg/L}$$

$$TSS: \quad \frac{25.0 \text{ lbs/day}}{0.0894 \text{ mgd} * 8.34} = 34 \text{ mg/L}$$

The non-degradation concentration for TSS will be the 30-day limit. 40 CFR 133.101(m) states that a 7-day average limit can be calculated using a factor of 1.5. Therefore, the TSS 7-day average limit is 1.5*34 mg/L = 51 mg/L.

Properly designed, operated and maintained aerated lagoons can consistently achieve effluent quality less than 30 mg/L BOD_5 (EPA, 1983). However a 30-day effluent limit of 10 mg/L BOD_5 may not be constantly or realistically achievable without a significant facility upgrade. Self-monitoring data indicates that the facility could not meet a 30-day BOD_5 effluent limit equal to 10 mg/L. Effluent quality of Outfall 002 is subject to a non significance review because of the increased flow above nondegradation levels, as required by 75-5-303, MCA and by rule at ARM 17.30.701-718 (Nondegradation of Water Quality). The nonsignificance review is detailed in Section IV.

Table 4: Outfall 001 Nondegradation and Actual Loads for POR

Nondegradation Allocated Load Limits			Actual 30-day Average Loads (lb/day)				
Parameter	Units	Annual Average Load	2002	2003	2004	2005	2006
BOD_5	lb/day	7.5	9.6	6.0	11.8	14.3	8.0
TSS	lb/day	25.0	15.6	17.5	21.5	34.5	12.8
TN	lb/day	8.4	6.5	6.7	6.8	7.5	5.4
TP	lb/day	2.1	1.2	1.4	1.3	1.5	1.2

Proposed TBELs:

The proposed technology-based limits, satisfying the requirements of ARM 17.30.1209 and the nondegradation rules at ARM 17.30.701-718, are given in Table 5. These limits are based on:

1. BOD_5 – Nondegradation limits: 30-day average = 10 mg/L, 7-day average = 15 mg/L.

   The previous permit applied national secondary treatment requirements for BOD_5 to the effluent.

2. TSS – Nondegradation limits: 30-day average = 34 mg/L, 7-day average = 51 mg/L. The previous permit did not apply nondegradation for an increased source and applied ASR to the effluent. ASR is appropriate for a facility that demonstrates, through continuous proper O&M, the facility cannot consistently achieve lower limits. The explanations from the permittee for permit exceedances show that the facility is frequently subjected to operational and equipment failures. Constant aerator issues have limited the actual treatment through this technology. Three of the five TSS exceedances reported for the POR had corresponding BOD_5 effluent violations.

ARM 17.30.1345 [40 CFR 122.45(f)(1)] requires that effluent limits must be expressed in terms of mass (mass/time), except for certain conditions, such as pH or temperature. For municipal treatment plants, mass based limits are based on design flow (discussed in Part II) for the facility.

Mass-based limits are calculated as follows:

Load (lbs/day) = Design Flow (mgd) x Concentration (mg/L) x Conversion Factor (8.34)

BOD_5:

30-d	Load = 0.089 mgd x 10 mg/L x 8.34	=	7.4 lb/day
7-d	Load = 0.089 mgd x 15 mg/L x 8.34	=	11.1 lb/day

TSS:

30-d	Load = 0.089 mgd x 34 mg/L x 8.34	=	25.2 lb/day
7-d	Load = 0.089 mgd x 51 mg/L x 8.34	=	37.9 lb/day

Table 5: Technology Based Effluent Limits[1]

Parameter	Units	Average Monthly Limit	Average Weekly Limit	Rationale
BOD_5	mg/L	10	15	ARM 17.30.701-718, Nondegradation of Water Quality; Percent removal: 40 CFR 133.102
	lb/day	7.4	11.1	
	% removal	85[2]	NA	
TSS	mg/L	34	51	ARM 17.30.701-718, Nondegradation of Water Quality; Percent removal: 40 CFR 133.105
	lb/day	25.2	37.9	
	% removal	65[3]	NA	
pH	s.u.	6.0-9.0 (instantaneous)		40 CFR 133.105 (c)

1. See Definitions section at end of permit for explanation of terms.
2. The arithmetic mean of the values for BOD_5 for effluent samples collected in a period of 30 consecutive days shall not exceed 15% of the arithmetic mean of the values for influent samples collected at approximately the same time during the same period (85% removal).
3. The arithmetic mean of the values for TSS for effluent samples collected in a period of 30 consecutive days shall not exceed 35% of the arithmetic mean of the values for influent samples collected at approximately the same time during the same period (65% removal).

IV. Water Quality-Based Effluent Limits

Permits are required to include water quality-based effluent limits (WQBEL) when technology-based effluent limits are not adequate to protect state water quality standards (40 CFR 122.44 and ARM 17.30.1344). ARM 17.30.637(2) states that no wastes may be discharged that can reasonably be expected to violate any state water quality standards. Montana water quality standards (ARM 17.30.601-670) define both water use classifications for all state waters and numeric and narrative standards that protect those designated uses. New sources, as defined in ARM 17.30.703(16), are subject to Montana Nondegradation Policy (75-5-303, MCA) and regulations (ARM 17.30.701-718).

A. Receiving Water

Outfall 002 discharges to the Sun River. The receiving water is classified as B-1 according to Montana Water Use Classifications, ARM 17.30.610**.** Waters classified B-1 are to be maintained suitable for drinking, culinary, and food processing purposes after conventional treatment; bathing, swimming, and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl, and furbearers; and agricultural and industrial water supply.

The Sun River is located in the Sun watershed, identified by the Untied States Geological Survey (USGS) as the 10030104 Hydrological Unit Code (HUC). The Montana stream segment ID is MT41K001_010, defined as the reach from Gibson Dam to Muddy Creek.

The USGS maintains two gauges near the discharge that were used to calculate a 7-day 10-year low flow (7Q10). Station 06089000, Sun River near Vaughn, is located downstream of the

wastewater discharge point and the Muddy Creek confluence. The 7Q10 of the Sun River at station 06089000 is 84 cubic feet per second (cfs) based on 67 years of record (USGS, 2004). Station 06088500, Muddy Creek at Vaughn, is located near the mouth of Muddy Creek. Based on 63 years of record, the 7Q10 for Muddy Creek is 12 cfs (USGS, 2004). The 7Q10 for the Sun River in the vicinity of the discharge is the difference between the two mentioned flows, or 72 cfs. ARM 17.30.635(4) requires that the design condition for disposal systems must be based on the 7Q10. The previous permit used the 7Q10 value at station 06089000.

The Sun River in the vicinity of the discharge is listed on the 1996 and 2006 303(d) list of impaired streams. Beneficial uses that were identified as impaired on the 1996 303(d) list cold water fishery and associated aquatic life, recreation and swimming. Probable sources were nutrients, siltation, thermal modification, flow alteration, and suspended solids. Probable sources of impairment do not include point sources.

The 2006 303(d) list states that the Sun River in the vicinity of the discharge does not support its aquatic life and cold-water fishery beneficial uses. Probable causes of impairment are identified as alteration in stream-side or littoral vegetative covers, other flow regime alterations, sedimentation/siltation, and water temperature. Probable sources of impairment do not include point sources.

The Department prepared a "Water Quality Restoration Plan and Total Maximum Daily Loads (TMDL) for the Sun River Planning Area" (herein referred to as the TMDL; DEQ, 2004) that was approved by the EPA in February 2005. The TMDL included the impairment listings as they appeared on the 2004 303(d) list and provided justification for the "removal" of the nutrient impairment on the upper Sun River (in the vicinity of the wastewater discharge). However, the stream segment immediately downstream of the discharge (Muddy Creek to the mouth), has nutrient TMDLs for total nitrogen (TN) and total phosphorus (TP). The EPA approved TMDLs for the Sun River are given in Appendix A.

The TMDL process apportions allowable pollutant discharge levels among the various users in the watershed; these include point and non-point sources of pollutants. The TMDL defined flow-based allocations for both nitrogen and phosphorus that apply during the summer (defined as May through September). The TMDL specifically identifies two permitted point sources (Vaughn and Sun Prairie Village) within the affected Sun River reach.

The TMDL determined Waste Load Allocations (WLA) for the point sources using river flow and EPA regional nutrient criteria for in-stream concentrations. For the total Sun River TN and TP TMDLs, 10% is allocated to the WLA (the remaining TMDL is 80% non-point sources and natural sources, and 10% margin of safety). Based on design information, the total point source input is 0.297 mgd (Vaughn design flow is 0.0894 mgd, Sun Prairie Village design flow is 0.189 mgd). The community of Vaughn is 32% of the total point source flow (0.0894 mgd/0.279mgd*100%).

TN and TP TMDLs for the lower Sun River are described by the following equations:

TN: TMDL (lbs/day) = 2.959 * flow (cfs).

TP: TMDL (lbs/day) = 0.269 * flow (cfs).

The Department uses 7-day average flow of the receiving water which is expected to occur on average once in 10-years (7Q10) for determining design conditions and limit derivation, as directed by ARM 17.30.635(4). For the impaired reach of the Sun River (from Muddy Creek to the Missouri River), the annual 7Q10 from the USGS station on the Sun River near Vaughn (06089000) is 84 cfs (note this is 12 cfs greater than the 7Q10 calculated for the Sun River near the point of discharge and upstream of Muddy Creek, as described in Part IV.B). The TN TMDL is 258.6 lb/day and the TP TMDL is 22.6 lb/day using the above stated equations at 84 cfs. The TN or TP WLA is 10% of the respective TMDL, which is 25.9 lb/day TN or 2.3 lb/day TP. The TN and TP WLA for Vaughn are 8.3 lb/day TN and 0.74 lb/day TP, 32% of the total WLA. The TN and TP nondegradation loads calculated for the former facility are 8.4 and 2.1 lb/day, respectively (Table 4).

The TMDL document states that, for the next permit cycle, the permittee will be required to meet the nondegradation loads as limits. A further analysis of this requirement is found in Part IV.D "Proposed WQBEL/WLA" of this statement of basis. The TMDL document also states that the permit will require an evaluation of the current facility and how total phosphorus effluent loading could be reduced during May through September. Details for the requirements of this evaluation, including dates for reports to the Department, are given in Part VII. "Special Conditions" of this statement of basis.

The Montana Fish, Wildlife and Parks (FWP) electronic fisheries database identifies fish species present as trout (brook, brown, and rainbow), black bullhead, burbot, common carp, fathead minnow, lake chub, longnose dace, sucker (longnose, mountain, and white), mottled sculpin, mountain whitefish, and northern pike. All species, except the brown and rainbow trout, are indicated as year-round residents (MFISH, 2007). The brown and rainbow trout are identified as "fluvial/adfluvial population, spawning elsewhere".

Receiving water quality data are limited. Table 6 summarizes those data retrieved from STORET, STOREASE, and the USGS databases.

Table 6: Ambient Water Quality Data					
Parameter	Units	Background Water Quality			
		Mean	Minimum	Maximum	Number data points
Temperature, winter [1]	°F	36.6	30.2	46.4	34
Temperature, summer [1]	°F	57.7	33.8	78.8	82
pH, winter [1]	s.u.	8.3	7.8	8.6	5
pH, summer [1]	s.u.	8.3	7.3	8.5	16
Total Ammonia as N, winter [1]	mg/L	0.034	< 0.01	0.16	8
Total Ammonia as N, summer [1]	mg/L	0.017	< 0.01	0.05	16
1. Winter is defined as November 1 through March 31; Summer is defined as April 1 through October 31.					

B. Mixing Zone

A mixing zone is an area where the effluent mixes with the receiving water and certain water quality standards may be exceeded [ARM 17.30.502(6)]. The Department must determine the applicability of currently granted mixing zones [ARM 17.30.505(1)]. Acute standards for any parameter may not be exceeded in any portion of the mixing zone unless the Department specifically finds that allowing minimal initial dilution will not threaten or impair existing beneficial uses (ARM 17.30.507(1)(b)).

Pursuant to ARM 17.30.505(1)(c) the discharge is considered an existing source for the purposes of establishing a mixing zone. For the Sun River (Outfall 002), the previous permit defined the mixing zone to extend from the discharge 1.5 miles downstream to a point in the NE ¼ of Section 25, Township 21 North, Range 1 East, just upstream of the mouth of Muddy Creek. The defined mixing zone was based on best professional judgment.

The volume available in a standard mixing zone is based on the dilution ratio between the 7Q10 and the discharge rate of the facility. One-hundred percent of the receiving water flow is used in mixing calculations for a facility that discharges a mean annual flow of less than one million gallons per day to a stream segment with a dilution ratio greater than or equal to 100:1. The design flow of the facility is 0.0894 mgd or 0.138 cfs. The dilution ratio of the receiving water to the discharge is 521 (72 cfs/0.138 cfs).

Total ammonia as nitrogen (N) is the only known parameter to require a mixing zone for this discharge.

C. Applicable Water Quality Standards

Discharges to surface waters classified B-1 are subject to the specific water quality standards of ARM 17.30.623 (March 2006), Department Circular DEQ-7 (February 2006), as well as the general provision of ARM 17.30.635 through 637. In addition to these standards, dischargers are also subject to ARM 17.30 Subchapter 5 (Mixing Zones, November 2004) and Subchapter 7 (Nondegradation of Water Quality, June 30, 2004).

ARM 17.30.635(4) requires that the design condition for disposal systems must be based on the 7-day average flow of the receiving water which is expected to occur on average once in 10-years (7Q10). More restrictive requirements may be necessary due to specific mixing zone requirements.

Pollutants typically present in domestic-dominated lagoon effluent that could exceed water quality standards include *Escherichia coli* (*E. coli*) bacteria, total ammonia, nutrients, low levels of dissolved oxygen (DO), and total residual chlorine when used to control pathogens.

Outfall 002 is an increased source and the nondegradation rules specify applicable water quality standards (ARM 17.30.701-718). The Department review of proposals for new or increased sources will determine the level of protection required for the impacted water, based on:

a) existing and anticipated used and the water quality necessary to protect those uses must be maintained and protected; and
b) degradation may be allowed only according to the procedures in ARM 17.30.708.

These rules apply to any activity that may cause degradation of high quality waters, for any parameter, unless the changes in existing water quality resulting from the activity are determined to be nonsignificant under ARM 17.30.715 or 17.30.716.

ARM 17.30.715 states criteria that are used to determine nonsignificance. These criteria consider the quality and strength of the pollutant, the length of time the changes will occur, and the character of the pollutant. For a surface water discharge to be considered nonsignificant, it must meet all of the following criteria:

1. Activities that would increase or decrease the mean monthly flow of a surface water by less than 15% or the 7Q10 by less than 10%;
2. Discharge containing carcinogenic parameters or parameters with a bioconcentration factor greater than 300 at concentrations less than or equal to the concentrations of the parameters in the receiving water;
3. Discharge containing toxic parameters or nutrients which will not cause changes that equal or exceed the trigger values in DEQ-7. Whenever the change exceeds the trigger value, the change is not significant if the resulting concentration outside a department designated mixing zone does not exceed 15% of the lowest applicable standard.
4. Changes in the water quality for any harmful parameter for which water quality standards have been adopted other than nitrogen, phosphorus, and carcinogenic, bioconcentrating, or toxic parameter, if the changes outside the mixing zone is less than 10% of the applicable standard and the existing water quality level is less than 40% of the standard.
5. Changes in the water quality for any parameter for which only a narrative standard exists if the changes will not have a measurable effect on any existing or anticipated use or cause measurable changes in aquatic life or ecological integrity.

Even if the trigger value is exceeded, a source may still be considered nonsignificant if the parameter of concern does not exceed 15% of the lowest applicable standard outside the mixing zone.

The current facility was designed to offer significant biological treatment, which is gauged through at least 65% removal of BOD_5. A discharge of BOD_5 can impact the receiving water DO. Pollutants present in domestic wastewater that will be subject to nonsignificance review are DO conditions related to effluent BOD_5 (as discussed in Part IV. D.).

Dissolved Oxygen (DO) – Freshwater aquatic life standards are characterized by the fishery (cold- or warm-water) and by the presence or absence of fish early life stages. Standards are further defined based on a time frame and required DO levels. B-1 waterbody classification states the receiving waters are cold-water fisheries. DO standards for B-1 waters are given in Table 8.

Table 8: B-1 Water Classification DO Standards

Dissolved Oxygen (mg/L)	30-Day Mean	7-Day Mean	7-Day Mean Minimum[3]	1-Day Minimum[3]
Early Life Stages[1,2]	N/A	9.5	N/A	8.0
Other Life Stages	6.5	N/A	5.0	4.0

Footnotes:
N/A – "not applicable"
1. These are water column concentrations recommended to achieve the required inter-gravel dissolved oxygen concentrations shown in parentheses. For species that have early life stages exposed directly to the water column, the figures in parentheses apply.
2. Includes all embryonic and larval stages and all juvenile forms of fish to 30-days following hatching.
3. All minima should be considered as instantaneous concentrations to be achieved at all times.

***Escherichia coli (E. coli)* Bacteria** - The permit will incorporate the recent change in the Montana state standards, which replaced fecal coliform bacteria, with *Escherichia coli* (*E. coli*), effective February 1, 2006. The applicable standards for *E. coli* are:

a. April 1 through October 31, of each year, the geometric mean number of the microbial species *E. coli* must not exceed 126 colony forming units (cfu) per 100 milliliters (mL), nor are 10% of the total samples during any 30-day period to exceed 252 cfu per 100 mL (ARM 17.30.623(2)(a)(i)); and

b. November 1 through March 31, of each year, the geometric mean number of *E. coli* shall not exceed 630 cfu per 100 mL and 10% of the samples during any 30-day period may not exceed 1,260 cfu per 100 mL (ARM 17.30.623(2)(a)(ii)).

Total Residual Chlorine (TRC) – DEQ-7 lists the acute and chronic aquatic life standards for total residual chlorine (TRC) as 0.019 mg/L and 0.011 mg/L, respectively (DEQ, 2006).

Total Ammonia as N – Total ammonia as N limits are developed based on standards that account for a combination of pH and temperature of the receiving stream, the presence or absence of salmonid species, and the presence or absence of fish in early life stages. Because pH and temperature can vary greatly on a seasonal basis, as can the presence or absence of fish in early life stages, DEQ Circular DEQ-7 (February 2006) allows for the determination of ammonia standards and the resulting limits on a seasonal basis. Salmonid fishes and their early life stages are presumed present year-round.

Water quality standards for total ammonia as N were calculated using the data in Table 6. The resulting standards are summarized in Table 7.

Table 7: Ammonia standard calculations (DEQ, 2006).

Condition	Period (1)	Salmonids Present	Early Life Stages Present	Ambient Condition		Water Quality Standard (4)
				pH	Temperature °C	
Acute	Annual	Yes	NA	8.5(2)	NA	2.14
Chronic	Winter	NA	Yes	8.4 (3)	6 (3)	1.29
Chronic	Summer	NA	Yes	8.4 (3)	17.5 (3)	1.06

NA – Not Applicable
Footnotes:
(1) Winter is defined as November 1 through March 31 and summer as April 1 through October 31.
(2) Based on 95th percentile of annual data.
(3) Based on 75th percentile of values in the applicable period.
(4) Based on Department Circular DEQ7 (February 2006)

Nutrients (TN and TP) – Montana does not have specific nutrient standards for the Sun River. ARM 17.30.637 says "state surface waters must be free from substances attributable to municipal discharges that will… create conditions which produce undesirable aquatic life". Nutrients, including nitrogen and phosphorus, in excess amounts can result in standing crop of algae that impedes flow and interferes with beneficial uses. Excessive algae are esthetically displeasing, can interfere with recreational uses, clog pumps and waterways, and create harmful conditions for aquatic life. Measurable affects of increased nutrients are aquatic plants, typically measured by chlorophyll (Chl) *a* and/or estimates of substrate cover.

The Department must incorporate approved TMDL waste load allocations developed for a point source in the appropriate MPDES permits (75-5-703(6), MCA). As stated in Part IV. A "Receiving Water Characteristics", TN and TP WLA were approved for the Sun River downstream of this permitted discharge. Both TN and TP WLA are flow-dependent and are 10% of the total TMDL for each pollutant. The Vaughn discharge accounts for 32% of the TN and TP WLA; the resulting allocated loads are 8.3 lb/day TN and 0.74 lb/day TP.

D. Proposed WQBEL/WLA

Effluent limits are required for all pollutants which demonstrate a reasonable potential to exceed numeric or narrative standards. The Department uses a mass balance equation to determine reasonable potential based on *"EPA Technical Support Document for Water Quality based*

Toxics Control (TSD)" (EPA, 1991). Input parameters are based on: 1) receiving water concentration and applicable low flow; and 2) the maximum projected effluent concentration at the maximum recorded discharge from the wastewater treatment facility.

Equation 1 expresses the described formula for determining RP.

$$C_{RP} = \frac{C_E Q_E + C_S Q_S}{Q_E + Q_S} \qquad \textit{(Eq. 1)}$$

Where:

C_{RP} = receiving water concentration after mixing, mg/L
C_E = maximum projected effluent concentration, mg/L
C_S = receiving water, upstream of discharge, mg/L
Q_S = applicable receiving water flow (7Q10), cfs
Q_E = facility design flow rate, cfs

TSS and pH – The facility provides a significant reduction in biological material and solids through secondary treatment (Section III). No additional WQBELs will be required for these parameters.

Dissolved Oxygen (DO) - National secondary treatment requirements are aimed at reducing organic material that creates an oxygen demand in the receiving water. Typically, facilities that provide significant removal of organic material, as measured by BOD_5, do not require effluent limits for DO. However, an analysis predicting the impacts of BOD_5 from this discharge on the receiving water must be performed to determine if the discharge is a nonsignificant source.

The 30-day average national secondary treatment requirement for BOD_5 was analyzed using the Streeter-Phelps equation (Thomann and Mueller, 1987; EPA, 1999) to determine if the BOD_5 limit would cause a DO sag and a violation of the DO standards. The Streeter-Phelps equation is a conservative steady-state equation that assumes a plug flow, and does not consider longitudinal diffusion from the plug. The equation makes simplifying assumptions limited to only point source contributions of biochemical oxygen demand. All other influences on the receiving water DO (photosynthesis, respiration, sediment oxygen demand) are assumed to be zero (EPA, 1999).

Design parameters, average effluent quality, and actual receiving water data were used in the Streeter-Phelps equation. Assumptions for re-aeration and deoxygenation rates were made using EPA guidance and text book theoretical values. All assumptions, variables, and the complete equation are documented in Appendix B. The equation uses Ultimate Oxygen Demand, UOD, which is the sum of CBOD (carbonaceous biochemical oxygen demand) and the oxygen demand required to convert effluent total ammonia to nitrate (UOD = CBOD + O_2 required for $NH_4 \rightarrow NO_{2/3}$).

The Streeter-Phelps equation predicts a downstream DO deficit, represented in this discussion and the equation as D_c. The following equation was used to determine the final D_c:

$$D_c = D_o e^{-K_a t} + \frac{W}{Q}\left(\frac{K_d}{K_a - K_r}\right)\left[e^{-K_r t} - e^{-K_a t}\right]$$

The initial receiving water DO deficient, D_o, is assumed to be zero. Therefore, the first term, $D_o e^{-K_a t}$, is zero and removed from the equation.

The total pollutant loading rate, W, is UOD multiplied by the facility design discharge rate then multiplied by a unit conversion factor (8.34 lb*L/mg*gal). The following assumptions were made to determine UOD:

1) The national secondary standard for CBOD of 25 mg/L was used;
2) CBOD was multiplied by a textbook value of *f*, an estimated ratio of ultimate CBOD to $CBOD_5$; for secondary treatment, *f* = 1.6 (Thomann and Mueller, 1987);
3) The annual average total ammonia as N value of 10.9 mg/L was used for the nitrogenous component; and
4) The total ammonia as N multiplied by 4.57, or the grams of oxygen consumed during ammonia conversion to nitrate (Thomann and Mueller, 1987).

UOD is 89.8 mg/L (UOD = 25 mg/L*1.6 + 10.9 mg/L*4.57); and
W is 67 lb/day (W=UOD*design discharge rate*8.34 = 89.8*0.0894 mgd*8.34).

In the equation, K represents rate values; these values are K_d = BOD deoxygenation rate, K_a= atmospheric re-aeration rate, and K_r = BOD loss rate. The rates were calculated using actual field specific data and theoretical values recommended by the EPA (1995). Values determined and details for each are provided in Appendix B.

The DO deficit, D_c, for the discharge is calculated to be 0.4 mg/L. This is the estimated decrease in the Sun River DO as a result of the wastewater discharge. The next step is to estimate the downstream impact of D_c on the receiving water DO and compare the result to DO standards in Table 8. If the downstream DO concentration is less than the standards, the effluent BOD_5 limit must be adjusted.

The minimum allowable DO relates to the receiving water DO saturation, c_s, which is dependent on temperature, salinity, and atmospheric pressure (corrected for elevation). For the Sun River, c_s is determined to be 10.1 mg/L. The following information and assumptions were made in determining c_s :

1) The USGS collected 74 paired data sets of temperature and DO from 1986-1994 at its station 06089000, located downstream of the discharge. The annual average temperature is 9.5°C.
2) Salinity data is unknown for the receiving water. However, fresh water salinity typically is less than 0.5 parts per thousand (ppt). Assuming this salinity (S) gives a chlorinity of approximately zero (S = 1.80655*chlorinity; Thomann and Mueller, 1987); therefore, the effects of salinity on c_s are negligible.
3) The elevation of the USGS station 06089000 is 3,340 feet above sea level. The DO saturation at this elevation is 88% of that at sea level.

Further explanation and assumptions used to determine c_s are explained in Appendix B. Thomann and Mueller (1987) have tabulated c_s values calculated *at sea level* for temperature and salinity.

The minimum DO of the receiving water downstream of the discharge can be estimated by subtracting D_c from c_s. For the existing load, the minimum DO is essentially equivalent to c_s – because D_c is low and negligible. Therefore, national secondary standards for BOD_5 are adequate for protecting the receiving water and the increased discharge is not significant.

ARM 17.30.1345(8)(a) states that all permit effluent limits must be expressed in terms of mass. The calculation for mass-based effluent limits for BOD_5 were discussed in Part III. Technlogy-Based Effluent Limits. The applicable mass based BOD_5 limits are:

BOD_5:			
30-d	Load = 0.089 mgd x 30 mg/L x 8.34	=	22.3 lb/day
7-d	Load = 0.089 mgd x 45 mg/L x 8.34	=	33.4 lb/day

***Escherichia coli (E. coli)* Bacteria –** A mixing zone is not appropriate for pathogens (as indicated by *E. coli* bacteria) because: 1) potential incomplete mixing of the effluent in the receiving water due the location of the effluent pipe; 2) the potential for public recreation [ARM 17.30.506(2)(b), recreational area, means public beach or swimming area, and adjacent streams or lakes]; and, 3) ARM 17.30.637(1)(e) which requires that state waters must be free from substances that are harmful or toxic to humans.

The *E. coli* bacteria standards given in the above section are applicable at the end of treatment. The existing facility is not equipped for disinfection. Final effluent limits for pathogens, as indicated by *E. coli* bacteria, will be effective April 1, 2012.

Total Residual Chlorine (TRC) –The TRC daily maximum limit is 0.019 mg/l; the TRC average monthly limit is 0.011 mg/L. Analytical methods in 40 CFR Part 136 requires chlorine samples to be analyzed immediately. On-site sampling for total residual chlorine with a chlorine meter using an approved method is required. The method must achieve a minimum detection level of 0.1 mg/l. Sampling of effluent with analytical results less than 0.1 mg/l is considered in compliance with the chlorine limit.

Total Ammonia as N - Reasonable potential (RP) to exceed the water quality standards for total ammonia-N was assessed using *Equation 1*, where:

C_{RP} = receiving water concentration after mixing, mg/L
C_E = maximum projected effluent concentration (43.1 mg/L)
C_S = receiving water concentration, upstream of discharge (0.01 mg/L)
Q_S = 7Q10 (72 cfs)
Q_E = facility design flow rate (0.138 cfs)

The projected maximum concentration for total ammonia – N was found following the method recommended by the EPA in the *"Technical Support Document for Water Quality-Based Toxics Control* (TSD)*"* (1991). This method requires a maximum projected effluent concentration. To calculate a maximum projected effluent concentration, monthly self-monitoring data supplied by the permittee from January 2005 through December 2006 (n=20) were used to determine. First, a standard deviation (10.09 mg/L) and the average concentration (10.9 mg/L) were found. From these, the coefficient of variation (CV) was calculated by dividing the standard deviation by the average concentration (10.09/10.9 = 0.92). The Table 3-2 in the TSD (at the 95% confidence interval) gave a multiplier of 1.5 for n=20 and CV = 0.9. The maximum reported effluent for total ammonia as N was 28.7 mg/L. The multiplier times the maximum concentration (1.5*28.7 mg/L) is 43.1 mg/L, which is the maximum projected effluent concentration.

The ambient receiving water concentration was found by calculating the median value based on 24 samples collected upstream of the discharge. Of the 24 reported total ammonia as N samples for the Sun River, 13 were reported to be less than the reporting limit (0.01 mg/L).

$$C_{RP} = \frac{(0.138*43.1) + (72.0*0.01)}{(0.138 + 72.0)} = 0.09 \text{ mg/L}$$

The resultant, 0.09 mg/L total ammonia as N, does not exceed any standard given in Table 7. An effluent limit for total ammonia as N is not necessary.

Nutrients (TN and TP) – The EPA approved TMDL did not allocate specific nutrient loads for the permitted discharge. The TMDL stated that for this permit cycle, the permittee will be held to the nondegradation load as the limit. Therefore, the 30-day average effluent limits are 8.4 lb/day TN and 2.1 lb/day TP.

3. Toxic Pollutants

ARM 17.30.623(2)(h) states that concentrations of carcinogenic, bio-concentrating, toxic, or harmful parameters which would remain in the water after conventional treatment may not exceed the applicable standards specified in Department Circular DEQ-7 (February 2006). The wastewater treatment facility treats domestic wastewater; toxic parameters are not expected to be present in the effluent. Monitoring for metals or organic substances in the effluent is not required.

Whole Effluent Toxicity (WET) Testing - ARM 17.30.637(1)(d) requires that state water be free from substances attributable to municipal waste that create condition which are harmful or toxic to human, animal, plant or aquatic life, except the Department may allow limited toxicity in a mixing zone provided certain conditions are met (Part IV. D).

The permittee operates a small discharge of less than 0.1 mgd with no identified industrial contributions. The dilution with the receiving water is greater than 500:1. No WET testing will be required with this permit cycle.

V. Final Effluent Limits

Effective upon issuance through March 31, 2012, the quality of the effluent shall meet the following limits.

Interim Effluent Limitations: Outfall 002				
Parameter	Units	Average Monthly Limit [1]	Average Weekly Limit [1]	Maximum Daily Limit [1]
Biological Oxygen Demand (BOD_5)	mg/L	30	45	--
	lb/day	22.3	33.4	--
Total Suspended Solids (TSS)	mg/L	34	51	--
	lb/day	25.2	37.9	--
Total Nitrogen [2]	lb/day	8.4	--	--
Total Phosphorus [2]	lb/day	2.1	--	--

Footnotes:
1. See Definition section at end of permit for explanation of terms.
2. Limit applies May 1 through September 30.

Effective April 1, 2012 and effective through the duration of the permit, the effluent quality shall meet the following limits.

Final Effluent Limitations: Outfall 002

Parameter	Units	Average Monthly Limit [1]	Average Weekly Limit [1]	Maximum Daily Limit [1]
Biological Oxygen Demand (BOD_5)	mg/L	30	45	--
	lb/day	22.3	33.4	--
Total Suspended Solids (TSS)	mg/L	34	51	--
	lb/day	25.2	37.9	--
E. coli bacteria [2, 4]	cfu/100mL	126	--	252
E. coli bacteria [3, 4]	cfu/100mL	630	--	1,260
Total Residual Chlorine (TRC)	mg/L	0.011	--	0.019
Total Nitrogen [5]	lb/day	8.4	--	--
Total Phosphorus [5]	lb/day	2.1	--	--

Footnotes:
1. See Definition section at end of permit for explanation of terms.
2. This limitation applies from April 1 through October 31.
3. This limitation applies from November 1 through March 31.
4. Report Geometric Mean if more than one sample is collected in the reporting period.
5. Limit applies May 1 through September 30.

VI. Monitoring Requirements

Influent and effluent monitoring are required to determine compliance with this permit, as stated at ARM 17.30.1342 (8). BOD_5, TSS, pH, pathogens as measured by *E. coli* bacteria, TN and TP have specific permit limitations. BOD_5 and TSS effluent monitoring is required once per week, due to the past compliance issues with effluent limits. Oil and Grease is required monitoring due to the relative short hydraulic retention time and the permittee's O&M history and violations.

Monitoring Requirements

Parameter	Unit	Sample Location	Sample Frequency	Sample Type[1]
Discharge flow rate	mgd	Effluent	1/Week	Instantaneous
Biological Oxygen Demand (BOD_5)	mg/L	Influent	1/Month	Composite
	mg/L	Effluent	1/Week	Grab
	% Removal[4]	Effluent	1/Month	Calculated
	lb/day	Effluent	1/Month	Calculated
Total Suspended Solids (TSS)	mg/L	Influent	1/Month	Composite
	mg/L	Effluent	1/Week	Grab
	% Removal[4]	Effluent	1/Month	Calculated
	lb/day	Effluent	1/Month	Calculated
pH	s.u.	Effluent	1/Month	Instantaneous
Temperature	°C	Effluent	1/Month	Instantaneous
E. coli bacteria	CFU/100mL	Effluent	1/Month	Grab
Total Residual Chlorine [2]	mg/L	Effluent	Daily	Grab
Oil and Grease [5]	mg/L	Effluent	1/Quarter	Grab
Total Ammonia, as N	mg/L	Effluent	1/Month	Grab
Nitrate + Nitrite, as N	mg/L	Effluent	1/Quarter	Grab
Kjeldahl Nitrogen, Total, as N	mg/L	Effluent	1/Quarter	Grab
Total Nitrogen [3]	mg/L	Effluent	1/Quarter	Calculated
	lb/day	Effluent	1/Quarter	Calculated
Total Phosphorus	mg/L	Effluent	1/Month	Grab
	lb/day	Effluent	1/Month	Calculated

Footnotes:
1. See Definition section at end of permit for explanation of terms.
2. The Permittee is only required to sample for total residual chlorine if chlorine is used as a disinfectant in the treatment process. If chlorine is *not* used, write "NA" on the DMR for this parameter.
3. Calculated as the sum of Nitrate + Nitrite (as N) and Total Kjeldahl Nitrogen (as N) concentrations.
4. See narrative discussion in this section of permit for additional details.
5. Use EPA Method 1664, Revision A: N-Hexane Extractable Material (HEM), or equivalent.

VII. Special Conditions

The Montana Water Quality Act requires the Department, after EPA approval of the TMDL, to incorporate the WLA development for point sources into appropriate water discharge permits (75-5703(6)(b), MCA). The EPA approved TMDL requires that the permittee instigate a planning strategy for TP reduction in the effluent and investigate approaches to reduce

discharged TP during the summer months. Part III.A. of the permit states that the permittee must comply with all conditions of this permit, which includes effluent limitations that protect water quality and beneficial uses. ARM 17.30.1342(1) states that the permittee must comply with effluent limits and conditions of the permit. ARM 17.30.1342 (8) requires that the permittee furnish to the Department, within a reasonable time, any information to determine compliance with this permit.

The results of this planning effort (a written report) are required 180 days before permit expiration and can be submitted with the renewal application package. The TMDL states that future permit development may require lower TP limits to achieve the TP TMDL.

The required report must review the current facility and how the technology reduces TP in the effluent. The plan should include (but not be limited to) and implement influent and effluent data collection during the summer months to generate actual loading and reduction rates for the existing facility. The report must also outline available options for TP reductions and cost estimates for each. Options are not restricted to the current facility configuration or technology (e.g. the report should include mechanical treatment and chemical addition for TP removal). The permit does not require implementation of any of the options.

VIII. Other Information

On September 21, 2000, a US District Judge issued an order stating that until all necessary total maximum daily loads (TMDLs) under Section 303(d) of the Clean Water Act are established for a particular water quality limited segment, the State is not to issue any new permits or increase permitted discharges under the MPDES program. The order was issued under the lawsuit Friends of the Wild Swan vs. US EPA et al, CV 97-35-M-DWM, District of Montana, Missoula Division.

The renewal of this permit does not conflict with Judge Molloy's order because the permit: 1) does not allow an increased in the discharge of pollutants for which the receiving water is listed as impaired by; and 2) incorporates EPA approved TMDL.

IX. Information Source

40 CFR, Parts 122, 136, July 1, 2000.

DEQ. Circular WQB-7, Montana Numeric Water Quality Standards. February 2006.

DEQ. ARM (Administrative Rules of Montana) 17.30.601-670. Montana Surface Water Quality Standards. February 2006.

DEQ. ARM 17.30.701-717. Nondegradation of Water Quality. June 2004.

DEQ. ARM 17.30.1201-1209, 17.30.1301-1387. Montana Pollutant Discharge Elimination System (MPDES). March 2003.

DEQ. 2006 Montana Integrated Water Quality Report. 2006.

DEQ. Water Qulaity Restoration Plan and Total Maximum Daily Loads for the Sun River Planning Area (TMDL). December 2004.

EPA. Office of Water. Design Manual for Municipal Wastewater Stabilization Ponds, EPA 625-1-83-015. October 1983.

EPA. Technical Guidance Manual for Developing Total Maximum Daily Loads – Book II: Streams and Rivers, Part 1: Biochemical Oxygen Demand/Dissolved Oxygen and Nutrients/Eutrophication. EPA 823-B-95-007. September 1995.

EPA. Technical Support Document for Water Quality-Based Toxics Control (TSD), EPA/505/2-30-001. March 1991.

MCA (Montana Code Annotated), Title 75-5-101 *et seq*., "Montana Water Quality Act". 2003.

MFISH – Montana Fish, Wildlife and Parks electronic fisheries database. Accessed on the web at: http://maps2.nris.mt.gov/scripts/esrimap.dll?name=MFISH&Cmd=INST. Accessed: May 28, 2007.

Neil Consultants, Inc. Vaughn Wastewater Treatment System – Operation and Maintenance Manual. Approved January 27, 1999.

Thomann, Robert V. and Mueller, John A. Principles of Surface Water Quality Modeling and Control. Harper-Collins Publishers. 1987

USGS (U. S. Geological Society). Water Resources of Montana (web page, address: http://mt.water.usgs.gov/). Accessed: June 13, 2007

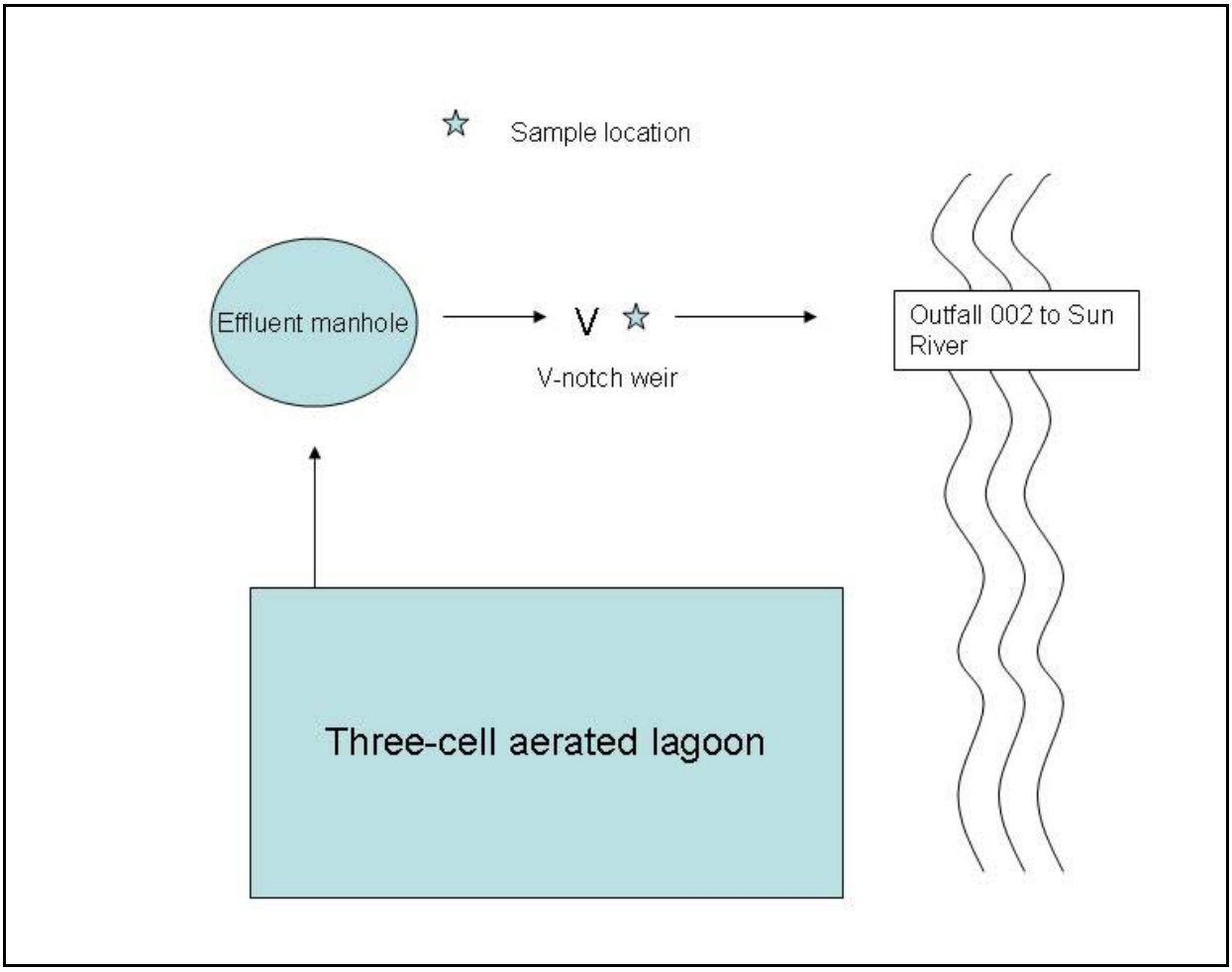

Figure 1: Facility flow diagram.

Prepared by: Rebecca Ridenour
Date: August 6, 2007

APPENDIX A – EPA Approved Nutrient TMDL

Waterbody (MT segment ID)	TMDL pollutant (based on 1996 and 2002 303(d) lists)	Water Quality goal./endpoint	TMDL	WLA
Upper Sun River (MT41K001_010)	Nutrients	"Justification provided for no need of a nutrient TMDL. Water quality standards are being met".		
Lower Sun River (MT41K001_020)	Nutrients – total nitrogen (TN)	TN = 0.650 mg/L	TMDL (lb/day) = 2.959*flow (cfs)	10% of TMDL
	Nutrients – total phosphorus (TP)	TP = 0.050 mg/L	TMDL (lb/day) = 0.269*flow (cfs)	10% of TMDL
Source: Enclosure 1 to EPA approval letter for the Sun River Planning Area Water Quality Restoration Plan and TMDL (2005)				

APPENDIX B

Streeter-Phelps equation (EPA, 1999): $D = D_o e^{-K_a t} + \frac{W}{Q}(\frac{K_d}{K_a - K_r})[e^{-K_r t} - e^{-K_a t}]$

Equation Parameter	Definition (units)	Value used in equation and supporting assumptions
D	DO deficit downstream of effluent (mg/L)	**0.04 mg/L**
D_o	Initial DO deficit	Zero
W	Total pollutant loading rate (lbs/day)	**67 lbs/day** based on: • Nat'l secondary standard for 30-day average CBOD = 25 mg/L. • CBOD/UCBOD ratio = 1.6 based on secondary treatment • NH_3-N = 10.9 mg/L (average effluent concentration for POR) * 4.57 (oxygen utilized in NH_3 conversion to NO_3) • Design flow = 0.0894 mgd = 0.1 cfs
Q	Total river flow (cfs)	**72.1 cfs** = Upstream flow (72 cfs) + effluent design flow (0.1 cfs)
K_d	Biochemical oxygen demand (BOD) deoxygenation rate	**2.2/day** – based on Figure A-6, EPA 823-B-95-007, 1995, and depth of 1 foot (obtained from actual physical data from USGS site 06089000)
K_a	Atmospheric re-aeration rate	**4.56/day –** based on Langbein & Durum "USGS equation" (EPA, 1995): $K_a = \frac{7.6U}{H^{1.33}}$, Where: U = average velocity (ft/sec), H = average depth (feet) Actual stream data: U = 0.6 ft/sec, H = 1.0 feet (using actual physical data collected by USGS at site 0608900 for a flow near 7Q10).
K_r	BOD loss rate	**K_r = 2.2/day** because: $K_r = K_d + K_s$, assume K_s(rate of settling) = zero
t	Time of passage from source to downstream location	Location where maximum DO deficit is projected to occur. **t = 0.3** days, based on: $t = \frac{1}{K_a - K_r}\ln(\frac{K_a}{K_r})$

The receiving water DO saturation, c_s, in equilibrium with the atmosphere is dependent on water temperature, salinity (chlorinity), and pressure. The saturation is also dependent on the receiving water elevation above sea level. Salinity (S) is related to chlorinity as: S = 1.80655 * chlorinity (Thomann and Mueller, 1987). Freshwater salinity is typically less than 0.5 parts per thousand (ppt). Therefore, chlorinity is 0.3 or negligible.

Water temperature data is available for the USGS station 06089000 for the Sun River at Vaughn. The average annual temperature recorded between 1986 and 1994, based on 74 data points that were paired with actual DO measurements, was 9.5°C. The elevation of the Sun River at USGS staion

06089000 is 3,340' feet above sea level (USGS, 2007). At a zero chlorinity and 9.5°C, c_s is 11.4 mg/L at sea level. An adjustment to the receiving water elevation is by the following equation: % c_s at sea level = 100-0.0035 H, where H = elevation (Thomann and Mueller, 1987). The receiving water c_s is 10.1 mg/L or 88% of c_s at sea level (% c_s at elevation = 100-0.0035*3,340 feet = 0.88, or 83%).